

ON THE



# ACTION OF ALCOHOLS.

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*Reprinted from the Transactions of the National Association for the  
Promotion of Social Science.*

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LONDON:

PRINTED BY EMILY FAITHFULL AND CO.,  
GREAT CORAM STREET, W.C.

1861.



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I PURPOSE in the following paper to state briefly the results which have been obtained from a new series of inquiries as to the exact influence in a scientific point of view, and the general effect of a moderate dose of alcohols; premising only that the experiments were not made with any reference to the temperance question, nor upon persons who hold strong views on either side, or who either totally abstain from, or considerably indulge in, the use of alcohols.

The plan pursued in the inquiries was to take the usual quantity of the alcohols—one and a half to two ounces, diluted in the usual degree—on an empty stomach, before breakfast, and whilst the body was in perfect rest; and by a method which has been described in the *Philosophical Transactions* for 1859, the effect upon the chemical changes in respiration as well as upon the pulsation was determined every ten minutes during its action; and the general effects were noted at the moment of their occurrence. Thus the period of the day was selected in which the body is both the most sensitive and the most vigorous, and all other influences being excluded during the action of the alcohols, it is believed that a nearer approach to truth has been made than in the less extended inquiries which have heretofore been recorded.

I first remark that the class of alcohols is a more heterogeneous one than has been generally admitted; for not only does the quantity of alcohol vary in each substance, but there are other important elements which are not common to the whole class. This is admitted in practice; for ales, wines, and spirits are not taken indiscriminately, neither have they the same influence, either when they are taken in an injurious degree, or when they are administered by the physician. Not only is the beer drinker readily distinguished from the spirit drinker, but he who is destroying himself by gin or brandy has

a very different aspect from the rum drinker. Nay, so nice is this practical discrimination, that even the quality of the spirit is regarded as of consequence to the system, and that quite independent of the quantity of alcohol which it contains. Moreover, the physician does not give a certain quantity of alcohol and consider it as ale, wine, or spirit, according to its degree of dilution. In all these respects common observation and instinctive action are far in advance of our scientific knowledge; and it should be the business of the experimental physiologist to ascertain the grounds on which common observation rests, rather than to take up some chemical theory, and speculate upon it. Truth is the basis of common instinctive action, and it is the test to which scientific observation must be brought.

It must, therefore, be accepted as a fundamental fact that the various kinds of alcohols have not one and the same action upon the animal system, and each kind must be separately investigated.

The substances which we have investigated are alcohol, rum, gin, brandy, sherry and port wines, ale and porter; and the experiments were very numerous, and extended over a period of many months. It was ascertained that all have two actions in common, viz., increasing the force of the heart's action and lessening the action of the skin, but in other important particulars their action was diverse.

The amount of the general effect upon the system depended upon the dose of the alcohol; and when that dose was  $1\frac{1}{2}$  to 2 ounces, or a quantity nearly sufficient to slightly intoxicate us, these effects were tolerably uniform, and were as follows, and in the following order:—

1. In so short a period as from two to seven minutes there was evidence of its presence in the brain, by a sensation of fulness at the crown and back of the head, or about the temples, according to the kind of spirit taken. This was not due to the force of the heart's impulse. After a short time it was lost in the next symptom, viz.:—

2. Lessened consciousness.—This occurred in from three to seven minutes, and as it increased, the power of fixing the attention was lessened; the perception of light, and we believe of sound also, was lessened; the power of directing and co-ordinating the muscles was lessened; and there was a marked, peculiar, non-intermittent purring or thrilling, and not unpleasant sensation, passing from above downwards throughout the whole body. This was the greatest in different experiments, at periods varying from fifteen to forty minutes, and continued at about the same degree during twenty to thirty minutes. After a period the effect diminished, and not unfrequently it seemed to lessen suddenly, as shown by increased perception of light, as though a veil had fallen from the eyes, by increased consciousness and power of directing the muscles. It must be remarked that the last power which was fully regained was that of consciousness—a fact which proves the persistent effect of the disturbed state of the brain after the actual presence of the alcohol is supposed to have passed away.

3. The increase in the action of the heart usually occurred in about three minutes, and was continued from thirty to forty minutes.

4. Coincident with the action upon the heart, was that upon the skin and the mucous membrane lining the mouth, as was shown by the dryness of the mouth and the dryness, heat, and swelling of the exposed parts of the skin, and particularly of the hands, with a general sensation of increased heat. This symptom increased in intensity for a time, so that with rum especially the skin felt as if dried by an east-wind. After about twenty to forty minutes, this sensation of heat was suddenly exchanged for one of cold, which was first perceived in the most sensitive part of the body, in reference to temperature, viz. between the shoulders; and at length, notwithstanding a suitable degree of atmospheric temperature and proper clothing, it sometimes became distressing, and led to continued shivering. The feet which had been hot became very cold. This change was often exceedingly marked, and did not at all correspond to the temperature of the skin, but was associated with cessation of the increase of the heart's action, and with a diminution of the sense of dryness of the skin.

5. The muscular system was influenced in a marked and definite degree. The early action upon the involuntary muscular fibre of the heart has been referred to. The thin layers of voluntary muscle found in various parts of the body showed great relaxation. The respiratory muscles acted in a powerful and gasping manner, so that there was a pumping, and quick, and therefore inefficient, inspiration in the earlier part, and a prolonged feeble expiration in the latter part of the action. At all periods there was a sense of impeded respiration. The muscles of the limbs were inactive, as shown by a state of immobility, or one of semi-catalepsy, one in which it was pleasant to leave the limb, or finger, even just where it happened then to be; and there was a decided indisposition to move it. There was relaxation of the muscles of the face, causing a hanging down of the countenance, and a marked stiffness of the muscles of the upper lip, cheeks and forehead, so that the expression of the features could not be readily altered.

This state of the muscular system followed the commencement of the effect on consciousness and other brain phenomena, and also the excited state of the heart; and in reference to the order of recovery, the power of co-ordinating the muscles was first regained, whilst the buzzing sensation, and hence catalepsy, continued yet longer, and the power to use the muscles of the face was the last to be restored.

6. The effect upon the mind was also marked and peculiar. With rum, my friend, whose countenance I could watch, had a flushed face and streaming eyes, and was very hilarious in about ten minutes; and for about fifty minutes seemed as happy as a king, but gradually we both felt less happy, and became less talkative, our excitement subsiding by degrees until we became quite taciturn and felt extremely miserable. Then we felt the horrors and the sorrows, as we had experienced the so-called pleasures, of the drunkard's lot, and saw how certain it was that he must again and again take the intoxicating draught. This change was generally coincident with



the shock and the lessened sensation of heat, and both generally proceeded *pari passu* until the end of the experiment.

7. The effect upon the secretions cannot now be referred to ; but whilst there was always a dry state of the membrane of the mouth, and, with rum especially, a soreness and a redness of the tip of the tongue, showing diminished mucous and salivary secretion, there was a temporary increase in the action of the kidneys. The action of the skin, mucous membranes, and salivary glands, was certainly lessened.

8. The duration of the effect varied both with the substance taken and the period of the year. In the spring-time it often seemed to pass away perfectly within two hours, but at other times the system was greatly disturbed and depressed during the whole morning, so much so as to compel me to lie down. As a general rule, however, the effects which could be readily traced passed away in from  $1\frac{1}{2}$  to 2 hours.

Without entering more at length into these general effects of alcohol upon the system, it must be evident that several very important questions have been raised; and we will now proceed to glance at them *seriatim*.

*Does alcohol increase muscular power?* This cannot be determined by any rigorous admeasurement, but only by the feeling and conduct of the individual under its influence ; and our firm conviction, after the most minute and careful attention to the subject, is, that it greatly lessens muscular action. This was abundantly shown by the comparative inability to move the body, and the relaxation of the muscles of the countenance, the sphincters and the thin layers of muscular fibres ; and as the effects of alcohol are temporary, and the dose must be renewed often to renew the effects, it appears to me that the direction of the action of one dose must be that of any number of doses ; whilst, as the inability referred to did not entirely disappear with the disappearance of the alcohol, it may be presumed that it would be progressively increased by constant repetition of the dose. In other words, muscular power and motion are lessened both in the occasional and the habitual drinker of alcohol.

*Does alcohol increase the heat of the body?* This is a difficult problem, for the sensation of heat less depends upon the absolute amount of heat generated within the body than upon the more or less free distribution of blood to the skin—to the organ alone by which, in health, we are cognizant of and measure the degree of heat. The thermometer applied to the axilla does not show an increase in the temperature of the blood under the influence of alcohol ; neither, indeed, does it commonly with ordinary food, for during the production of an increased amount of heat the excess is contemporaneously removed by the action of the skin. Our experiments, however, do not leave the impression upon our minds that there is an increased amount of heat generated, for a remarkable sense of chilliness was always observed in about three-quarters of an hour after the alcohol had been taken. It is, however, certain, that for a time the surface is warmer when alcohol has been taken, and equally certain

that this is due to an increased amount of warm blood circulating on the superficies, as the swollen and red hands and face readily prove.

It is also true, without doubt, that the action of the skin is lessened, and as the effect of this has been overlooked in all discussions of this question, I am very desirous to give it here its due weight. The skin is the great refrigerating organ of the body, both by being the part which comes into contact with the air and by the evaporation of the fluids brought to it by the blood. The direct action by radiation is too manifest to require further notice, but it is not commonly appreciated in how great a degree the perspiration, insensible as it may be, cools the body. This is effected by the conversion of sensible into latent heat, on the law established by Black; so that, whatever amount of latent heat there may be in a fluid, there will require 1000 times more as that fluid is being converted into vapour. Hence, as at every moment there is evaporation proceeding on the skin, there must be a corresponding abstraction of heat and cooling of the body; and this is so nicely regulated that excess of heat is removed almost as soon as it occurs. This view at once shows the paramount importance of the skin in the animal economy; for as the skin is active, so must heat be abstracted, so must heat be generated, so must food be transformed, so must food, both fluid and solid, be supplied and digested, and so must the heart and arteries convey the fluid to the surface. The skin is, in fact, the controller of almost all organic actions. It will also show to us the influence of alcohol over the bodily functions, when it is understood that of all agents, scarcely excepting cold, it has the greatest power in lessening the action of the skin. To lessen the action of the skin, and thus prevent waste of heat, is so far equal to producing heat, and this being effected, the chain of phenomena just mentioned follow. Thus in their order—first, lessening of the action of the skin; second, saving of heat; and third, less necessity for the production of heat, for the assimilation of food, for the digestion of food, for the supply of food, for the supply of fluid, and for the rapidity of circulation. As alcohol, like all other agents, varies in its action upon different persons and upon the same person under different conditions, the derived effects will vary precisely as the fundamental action varies—that is, as is the action upon the skin so will be the dependent conditions.

In this way we account for and explain the increased sensation of heat which follows the use of alcohol; but it is to be remarked that this sensation is very evanescent, and is followed by increased sensibility to cold. It has already been remarked that this secondary effect is concomitant with the evidence of removal of the alcohol from the body, and therefore of its lessened action upon the brain and skin; but it is so peculiar and sometimes so distressing, and is so little in relation to any change in the atmospheric temperature, that it cannot be altogether accounted for on physical grounds. The measure of cold by our sensations depends upon the sensibility of that part of the nervous system which gives the sensation; and that

this is not a constant but a very varying state is shown by the fact that fifty-five degrees of temperature feels cold to us in summer, but warm to us in winter. Whatever, then, may vary this function of the nervous system may vary the sensation of heat, quite apart from the physical agencies which alone cause and vary the sensation when the power of sensibility remains a constant quantity, so to speak. It is to this disturbance in the status of the nerves which are sensitive to temperature, that this secondary action of alcohol must be attributed; and I cannot perhaps find a more suitable opportunity than the present for transcribing a remark which was made by me at every step of our inquiries, viz. that alcohol is the great *disturber* of the system.

*Does alcohol nourish the system?*—regarding the question in the wider view of supplying any materials which can meet any wants of the system. This part of the inquiry has been much fettered by the chemical view which has been so ably introduced into all questions of nutrition, which divides foods absolutely into two classes—those which supply heat, and those which supply the elements of tissue, as though such a division of action did absolutely occur within the body. Our experiments have, we trust, tended to prove that there cannot be any such rigorous division of duty; but that, on the other hand, both kinds of food act together; and that the nitrogeous is necessary to the transformation of the hydro-carbonaceous kind of food. It has also been fettered by the assumption that the alcohol must be transformed, as into carbonic acid and water, and heat be generated; but it must be admitted that there are only chemical theoretical grounds for this statement. Alcohol is found unchanged in the brain and tissues, and the breath of the drinker is laden with the fumes of untransformed alcohol; and although alcohol, as such, has not yet been found in the urinary excretion, there is great reason to believe that it passes off without the ultimate transformation referred to.\* In our experiments, alcohol always caused a small increase in the chemical changes of respiration, an increase amounting to one-eighth or one-quarter of a grain of carbonic acid per minute during their action; but this was due, as we believe, not to the conversion of the carbon of the alcohol into carbonic acid at that period (see *Philosophical Magazine*, Dec. 1859), but to the excited action of all the organic functions of the body, and which in an indirect manner only caused increased waste and did not yield increased supply. This, however, is the action on which the various kinds of alcohol exert a different influence. Rum agrees with alcohol in this

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\* Since this paper was read, a work has appeared in France, in which M. Lallemand has shown by reagents that alcohol passes off without decomposition, by the lungs, skin, &c., for a period of eight hours after it has been taken. These experiments are not conclusive, since they have not returned to us the alcohol which had been drunk, neither was the quantity acting as a reagent at all equal to that which had been taken; but so far as they go, they support the views above written.



action, but has an increased influence which may be partly due to the presence of a certain quantity of saccharine matter in the colouring of the rum (for sugar greatly increases the amount of carbonic acid produced); but good brandy and gin invariably lessened the amount of chemical change, whilst whisky varied somewhat in its effect, according to the sample used. These are all compounds of alcohol and various volatile oils and ethers, and that the latter class of substances exert a powerful influence over the system is proved by the effects of perfumes, which exhilarate powerfully in many persons, but in some induce serious symptoms. These have not been carefully investigated, but they cannot longer be overlooked.

It was, however, invariably remarked by us that there was this broad line of distinction between alcohols and true foods, viz. that the latter acted in a uniform and definite manner, whilst the former exhibited great uncertainty and variation: and, in fact, instead of nourishing, disturbed the vital actions. We could not regard alcohols in their effects upon ourselves as having at all the nature of true foods.

*Do alcohols promote the digestion of food?* This has been denied, because the action of alcohol is to harden animal substances immersed in it: but a more feasible argument is, that it tends to lessen, or it arrests the salivary and the mucous secretion, and probably the secretions of other glands which are required in the transformation of food; and when this does occur, the power to transform or digest starchy food must be very greatly lessened. In this manner it may be affirmed that alcohols seriously impede digestion; but there are other conditions in which there is good reason to believe that they improve it, viz. some of those in which the tone of the stomach is greatly lessened, and in which the drinking of a small quantity of strong spirit is followed by a sensation of relief.

*Do alcohols lessen waste?* From what has already been stated in reference to the skin, it is clear that they have this action temporarily; but the amount of it rests upon the degree of action of the skin on the one hand, and upon the effect upon the respiration on the other. It is clear that rum and pure alcohol have this action in a less degree than that excited by brandy and gin, and that whisky occupies a medium position.

*Does alcohol tend to promote brain activity in the production of thought?* In the healthy and well-balanced brain, we say certainly not; but, on the contrary, it seriously disturbs and impedes thought. In all experiments, the mental perception was greatly lessened, so that it was impossible to conduct any train of thought during any period of the alcoholic action; and we are fully convinced that alcohol in any quantity in a degree lessens that mental perception which is necessary for the due sequence and combination of ideas. It appears, however, to be true that it in a degree tends to the activity of the imagination, and in many instances of literary men of debauched habits it has been necessary to stimulate the system before the will

could be fully enlisted in the act of mental labour. Such, however, are states of disease.

*Is, then, alcohol a good or a necessary agent; or is it injurious or unnecessary?* This is the practical issue of such inquiries, and is the point of dispute amongst both the learned and the unlearned; because they will make that a simple which is a complicated inquiry, and will have a general application of that which is essentially dependent upon varying conditions. Health is not an unchanging unity, neither can men universally be regarded as its exemplification; but it is an ideal condition of the most varying and dependent kind. Men are not placed in one unchanging condition, but in conditions which are constantly changing into their opposites. Even in the same climate, and with the same kind of occupation and food, I have shown, in papers published by the Royal Society and the Royal Medico-Chirurgical Society, that change of season causes a never-ending change in the amount of vital and chemical action, and that to so great an extent, that at the end of a hot summer the vital actions are only two-thirds of the amount proceeding in the vigour and activity of spring—a perpetual eyele, at every moment bringing and curing disease. How, then, can so general a question be answered? Only by arranging controlling conditions into categories.

*Is alcohol good or necessary in the ordinary conditions of a healthy system, where food and exertion fairly balance want and supply?* I answer emphatically, no. In such a state alcohol is a poison which disturbs the balance of vital action necessary to health, and which, according to its dose and the sensitiveness of the system, and the power to resist evil influences which the good providence of God has so wisely bestowed upon our infirmities, must tend to induce disease. It is, then, not good, much less is it necessary; it may be more or less indifferent.

*Can it be a substitute for food?* Certainly not.

*Can food do all the good, if any, that alcohol can do? Or can food be a substitute for alcohol?* Our experiments enable us to give an answer to this question. In the action upon the heart and skin all nitrogeneous foods and fats have a parallel action. Thus—coffee, milk, fat, meat, and some elements in all grains, are substitutes; and of these, coffee, milk, and fat are the more powerful, and coffee the most powerful. The most influential mixture of these is undoubtedly coffee, and some kinds of alcohol, and then the well-known rum and milk, or beer and milk.

In the ordinary conditions of the system, I believe that foods can supply every good which alcohol can afford, and that without any disturbing or otherwise injurious influence. Moreover, in all extraordinary conditions in which men can be placed with ordinary health, as, for example, under great exertion and exposure to great cold, a full supply of the above-mentioned foods would fulfil all the conditions under which alcohol could be required.

*Is, then, alcohol, under all conditions and circumstances injurious or unnecessary?* Certainly not.

The problem to be solved is the due balance of want and supply, so that a due amount of animal heat and animal strength may be maintained. In the absence of due supply, it has been shown how far alcohol has power to meet the necessity, as, for example, in the instance quoted by Dr. Carpenter, in which a gentleman travelling on a very cold morning found great comfort, and, as he believes, the preservation of his life, in taking alcohols repeatedly in the absence of food—a statement which is met, not by a denial of its truth, but by the counter statement that under similar conditions the learned professor had found coffee and plenty of good food to meet the requirements equally well. But the question is not the relative value of alcohol and food, but the value of alcohols in the absence of food, and in such an unfortunate condition, or even with insufficient food, I think that alcohol must be admitted to have power by lessening waste of heat, and to temporarily lessen the necessity for food, and so far to be not injurious and not unnecessary. In estimating this necessity we must not be guided by any exactly defined amount of food, but by the absolute requirements of the system in the conditions in which a man may be placed. In the polar regions there must be a greatly increased supply of food, and that of the kind mentioned as substituting alcohol, and with sufficient of such food, alcohol must be injurious and unnecessary. In the tropics, the great difficulty is in so far reducing the amount of food that the production of heat shall not be in excess, when the body would receive its natural warmth from the atmosphere if it were mere dead matter, and yet that there shall be sufficient in both quantity and kind to maintain animal power and activity. Such a condition would be impossible were it not for the free action of the skin before referred to—an action upon which the life even of men so placed is dependent at every moment. How fearful, then, must be the risk of introducing into the system alcohol with its vast power of arresting this action. To this, above all things, is to be attributed the liability to sun-stroke and to other diseases of hot climates, as I have elsewhere shown; and how great is the responsibility of those, whether connected with the Government or otherwise, who sanction or encourage the introduction of our strong ales into India, unless it be found that only by so doing can the men be drawn from the use of stronger alcohols.

There is, however, here a condition in which alcohols must be admitted to be neither injurious nor unnecessary—that in which the skin is more active than the body needs, or than the heart can support, and in which the vital powers become enfeebled. This can only in part be met by food; for the power to transform food is greatly lessened, but it may be nearly or quite as well supplied by the proper use of coffee. Such a state must be common in India, and is also that of cholera in temperate climates, in the form in which the skin is bathed in perspiration and the body is cooling too rapidly, when large quantities of brandy are drunk with the best results; and such also are some stages of fever and exhaustion, when the heart's action is feeble and the skin active; and some other conditions which are known



only to the physician. Lastly, it is known that the Highlander can drink an almost incredible quantity of raw spirits when exposed to the rigours of his climate, and in the absence of enough of that kind of food which, as above mentioned, substitutes alcohol. It then has no effect upon the brain, but maintains animal heat and enables him to complete his journey; and who can say that in such a case the alcohol was either injurious or unnecessary? Certainly that could not be inferred from the cases in which the same men become besotted by drinking alcohol under conditions which do not call for it.

All the foregoing has special reference to the class of alcohols known as spirits, but it is applicable to any substance which contains an equal amount of alcohol. Time compels me to pass over the action of wine, and to conclude with a remark on beer, to which I attach great importance. Beers contain gluten and sugar; and although the trite remark as to the small amount of nutriment which they contain may be true, we have proved that gluten and sugar have a powerful action in promoting the transformation or digestion of starchy food; and hence that beers, by their gluten and sugar, have the important power of calling into action the food which is already in the system. This is equivalent to a supply of food, and more particularly when conjoined with this we have alcohol, which lessens the waste of heat by the skin. Ales, then, which are rich in sugar and gluten, and poor comparatively in alcohol, have an important and most useful, but, not in health, necessary action, in increasing the use of food, although they may supply but very little food. These ales are the good home-brewed ales of our fathers' days, and not the deluding and valueless bitter beers which have become so expensive and so fashionable in our day. But for this dietetic effect it is only necessary that a small quantity should be taken, for it is true of all ferments that a large quantity does not induce a proportionately large result.

The greatest improvement which could be effected in reference to the habits of the community would be to induce the habit of drinking ales out of wine-glasses, for the purpose above mentioned is better effected by a wine-glass full than by a pint of ale. To take beer as a digestive, and not merely as a diluent, much less as an exhilarating agent, would be to give a rational character to its use, and would greatly tend to its disuse as an intoxicating beverage. Good ale and stout in our experiments always increased the chemical respiratory changes to the extent of more than one grain of carbonic acid per minute, or about one-sixth of the total quantity, and hence they are proved to have the digestive action above described and to be true restoratives if the quantity just mentioned be not exceeded.

In conclusion, we may sum up our remarks by the statement that alcohols, when taken in health, pseudo-health, or in disease, should only be taken as medicines.